Interim Contractor Report #10

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Physics of Boundaries and their Interactions in Space Plasmas

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I. Large Scale Simulation of the Magnetopause:

We have resolved all the issues related to the imposition and treatment of the dipole field in the 2-D hybrid code. We have been able to avoid the pile up of the magnetic field in the 2-D simulations and have successfully completed a number of test runs. We have now started to perform production runs and will spend a great deal of time analyzing the results. As part of this analysis, we are further refining our visualization tools, as well as data handling software. These large kinetic simulations produce copious amount of data and special techniques are required to manipulate and handle them. We have submitted an abstract for the Fall AGU and plan to present one talk and one poster on these results.

II. Three-dimensional Hybrid Simulations:

We have also made significant progress in our study of the three-dimensional instabilities at the magnetopause. We have now completed three large runs on the parallel machine Cray T3D, and are in the early stages of analyzing and interpreting the results. Our preliminary analysis reveals a complex interplay between the Kelvin-Helmholtz instability and the tearing mode. We have submitted an abstract for the Fall AGU meeting where we will discuss our results. As a means of facilitating a better understanding of these simulations results, we have started to develop an electromagnetic linear code which would enable us, for the first time, to examine the linear properties of the Kelvin-Helmholtz instability of thin current sheets in the fully kinetic regime, thus fully accounting for effects such as finite Larmor radius effects. We have successfully tested an electrostatic version of this code and are now extending it to the electromagnetic regime. The results of this investigation will also be presented at the fall AGU meeting.

III. Inflow-Outflow Boundary Conditions:

In the above 3-D simulations, we are imposing periodic boundary conditions in two directions. Our eventual goal is to implement inflow-outflow boundary conditions in our 3-D runs. To this end, we are continuing our work on the implementation of the inflow-outflow boundary conditions for the asymmetric configuration at the magnetopause in our 2-D and 3-D hybrid codes. Since most of the large scale runs will have to be done on the parallel machine, we are evaluating several different techniques for parallelizing the code to find the optimal solution in terms of minimizing the communication between the different processors, and increasing the overall CPU performance of our codes.